Introduction to Computed Tomography as an aid to Forensic Analysis

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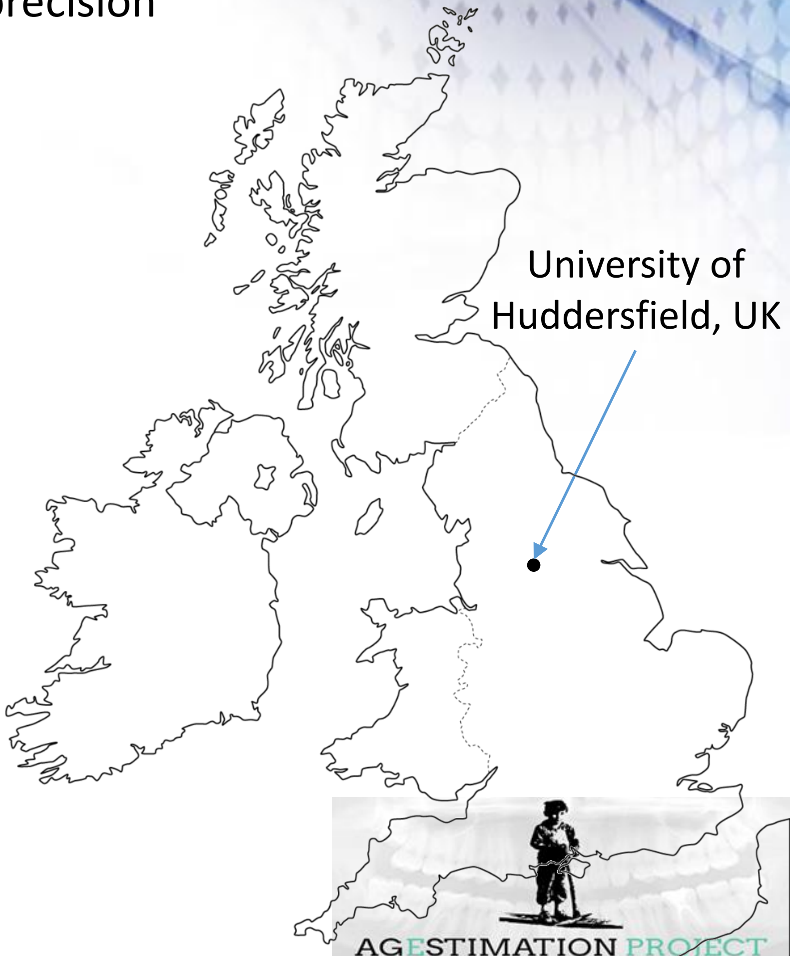
EPSRC Centre for Innovative Manufacturing in Advanced Metrology.

Nationally funded, centre of excellence in advance metrology. Based at the University of Huddersfield's Centre for Precision Technologies, with an international reputation in precision engineering, metrology research and standards development.

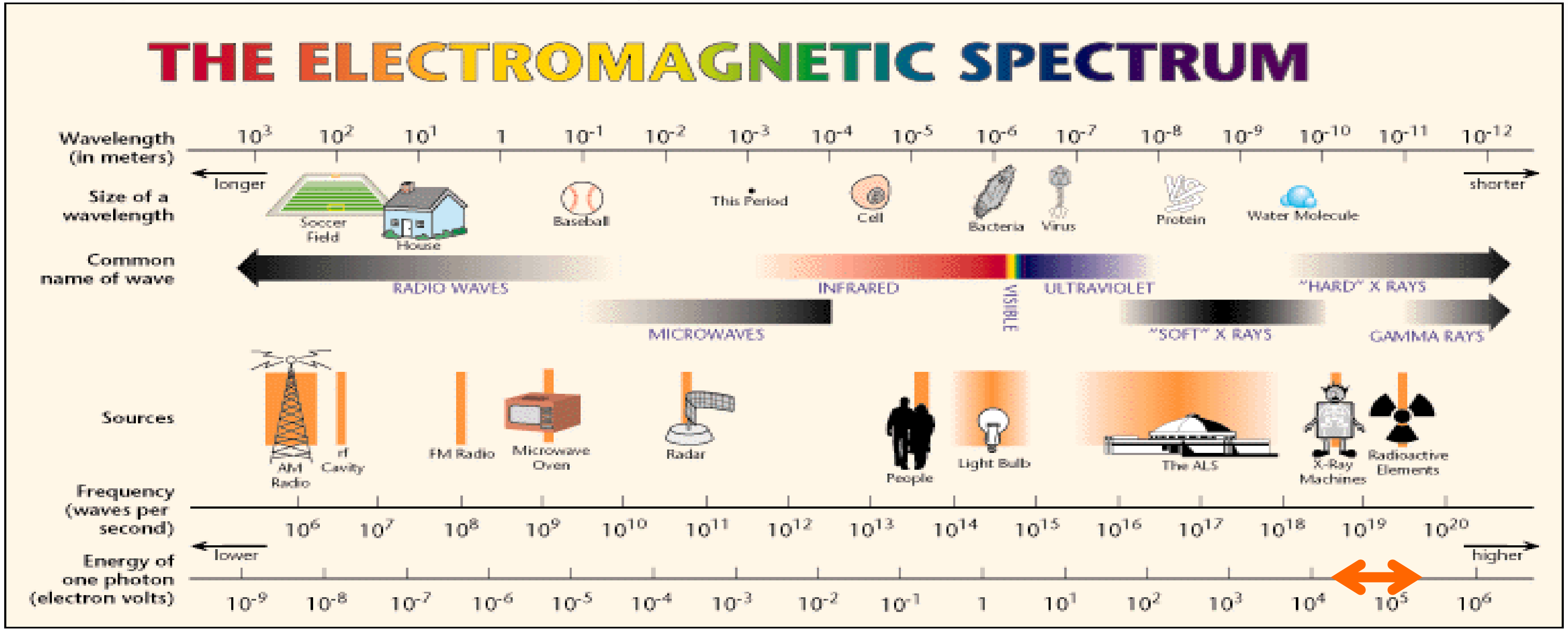
Key areas of research are:

- Additive Manufacturing
- Software Development
- Hardware Applications
- Surface Measurement & Applications
- Ultra Precision Manufacturing
- Industrial Metrology



What are X-rays?

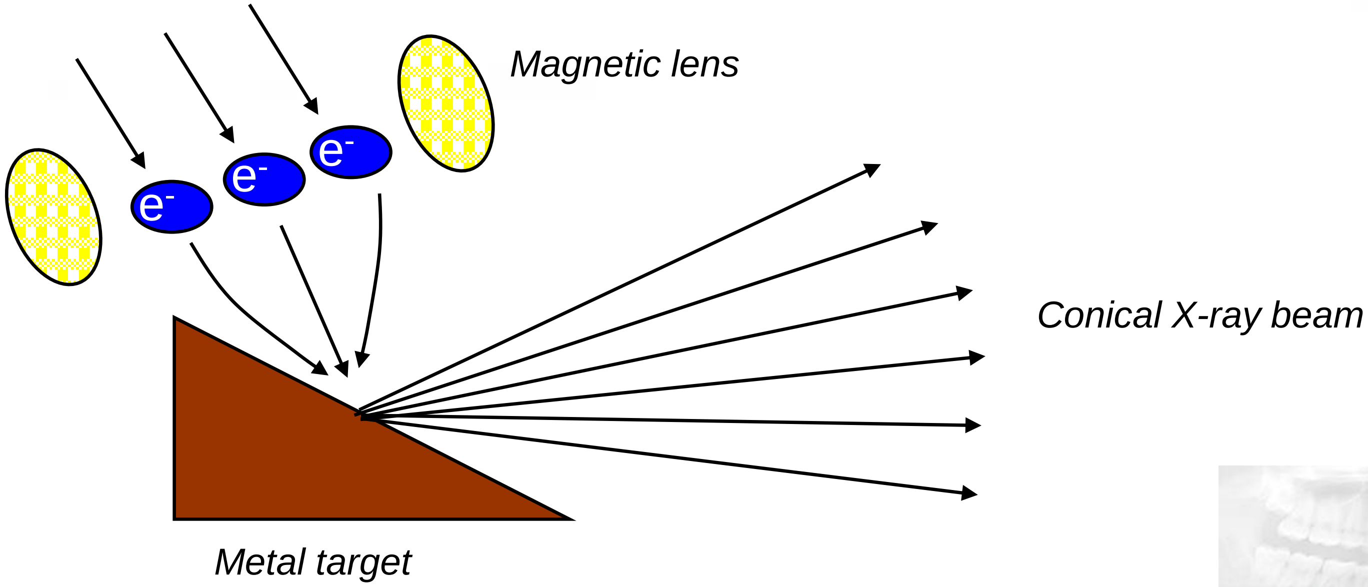
- X-rays are electromagnetic radiation just like visible light, infra-red light, ultra-violet light and radio waves, but with a much shorter wavelength than any of these.



Typical μCT X-ray sources produce energies in the range 30-450keV (in red).

How do we generate X-rays?

- We generate X-rays by firing electrons at high speed on to a metal target.
  - Electrons are produced from a hot filament (like a light bulb).
  - They are accelerated using a high voltage into a beam tube.
  - They travel at up to 80% the speed of light (giving them energies of 30 - 450keV).
  - They are focused by a magnetic lens into a small spot (1 – 5µm) onto a metal target.
  - The sudden deceleration of the charged electrons when they hit the target produces 99.3% heat and 0.7% X-rays.



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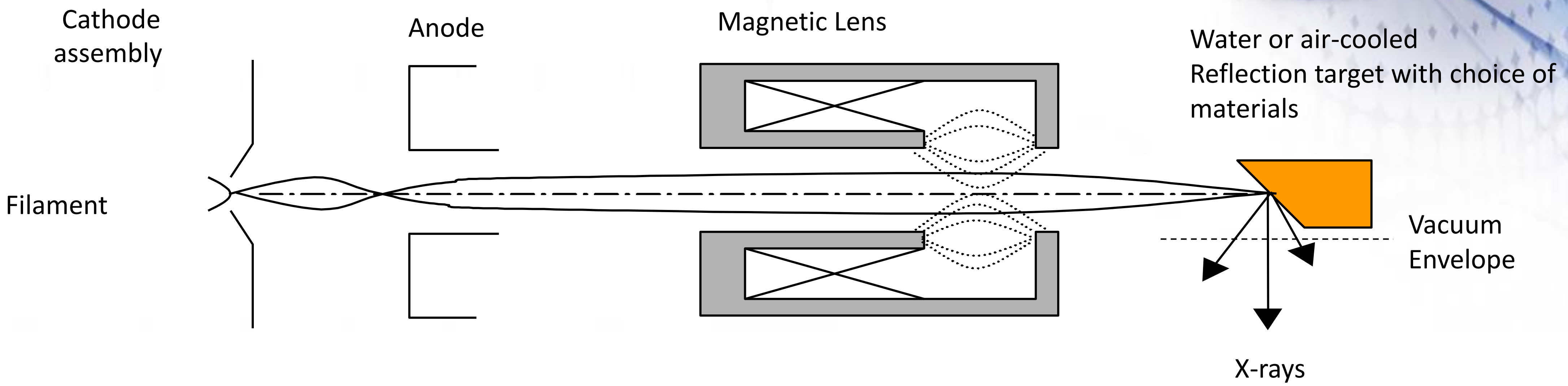
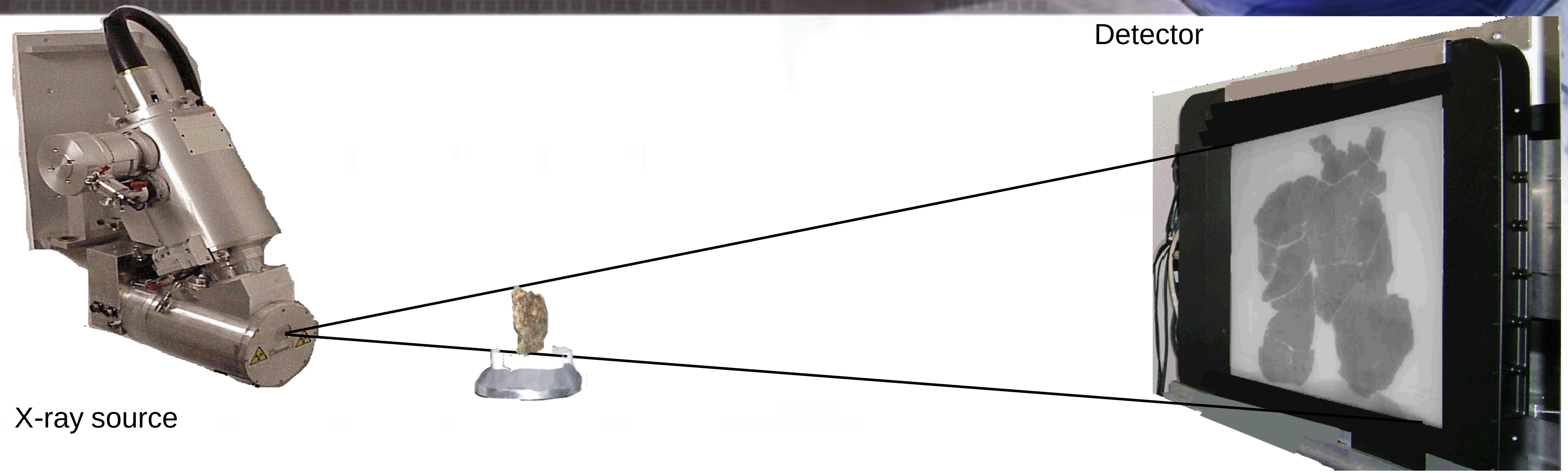
X-ray Source: Reflection target



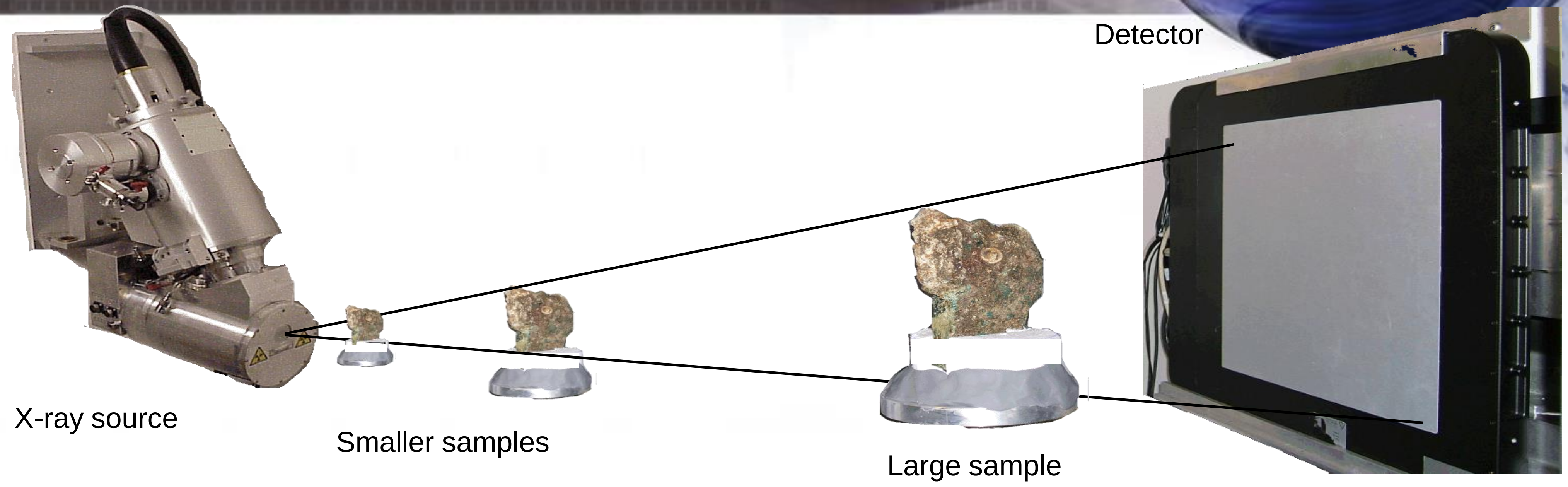
Note: Reflection target limits the maximum magnification as the target is behind the vacuum window

How do we get an X-ray image?



X-rays travel in straight lines and pass right through the sample. However, some of the X-rays are absorbed by the sample and so the intensity of the X-rays is reduced forming a shadow image.

How do we get a magnified image?



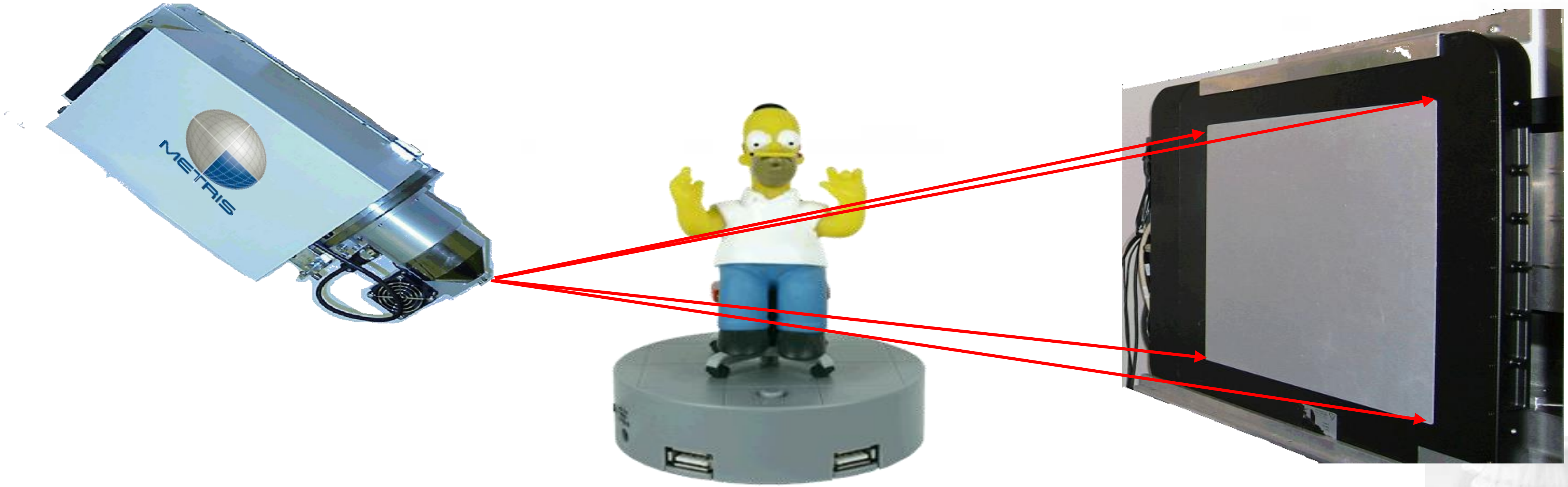
Just like light, X-rays travel in straight lines.
Unlike light, we cannot use a lens, so we use geometric magnification.

The magnification is increased by moving the sample closer to the X-ray source (and vice versa).

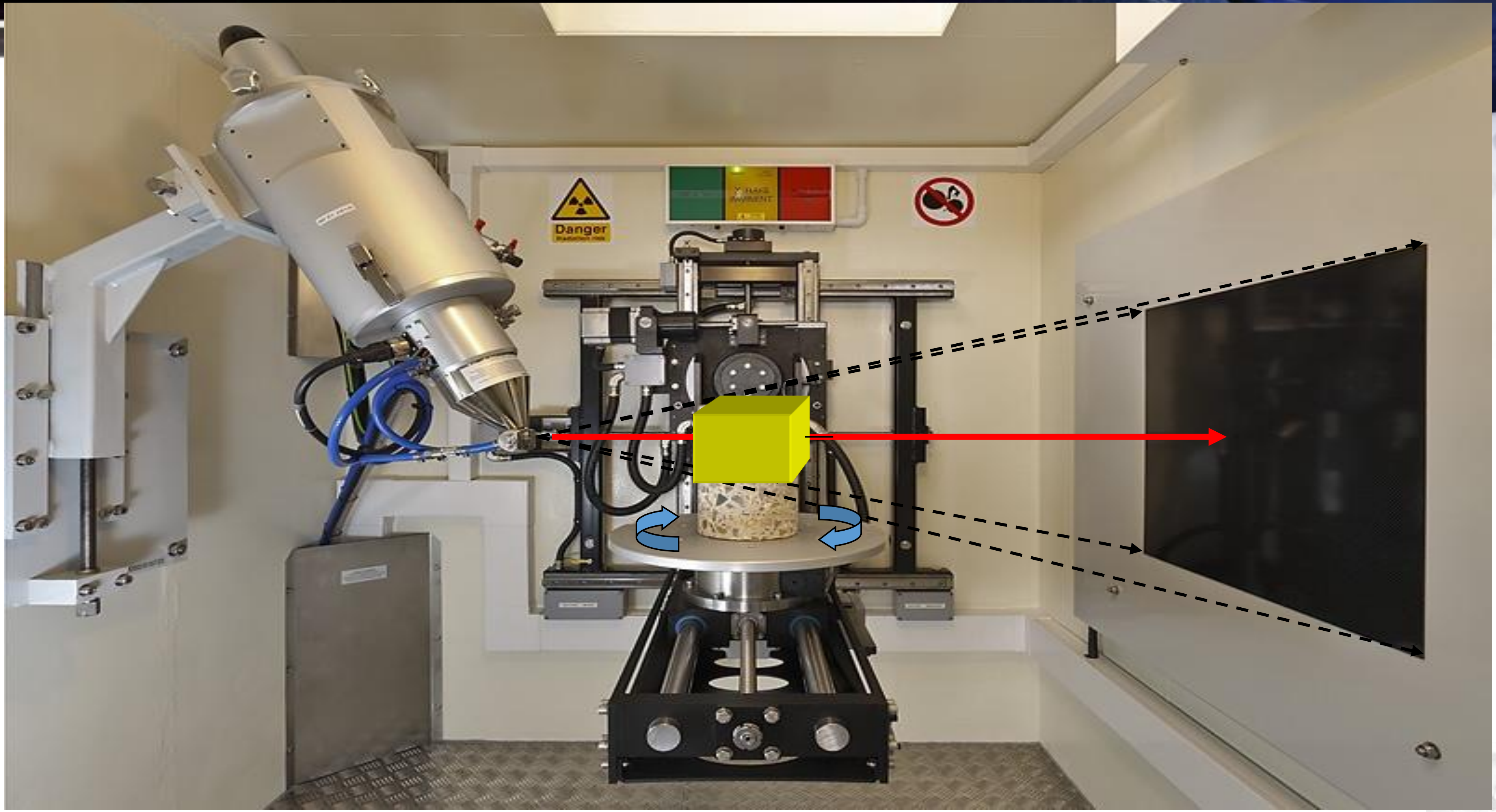
What is Computed Tomography?

- Computed Tomography (or CT) is the process of imaging an object from all directions using penetrating radiation (e.g. X-rays) and using a computer to reconstruct the internal 3-D structure of the object from the intensity values in the projected images.

- It is the process used in a medical CT scanner, though in our case we keep the source and detector stationary and rotate the object. Hospital patients might complain if we did this to them!



How does CT actually work?



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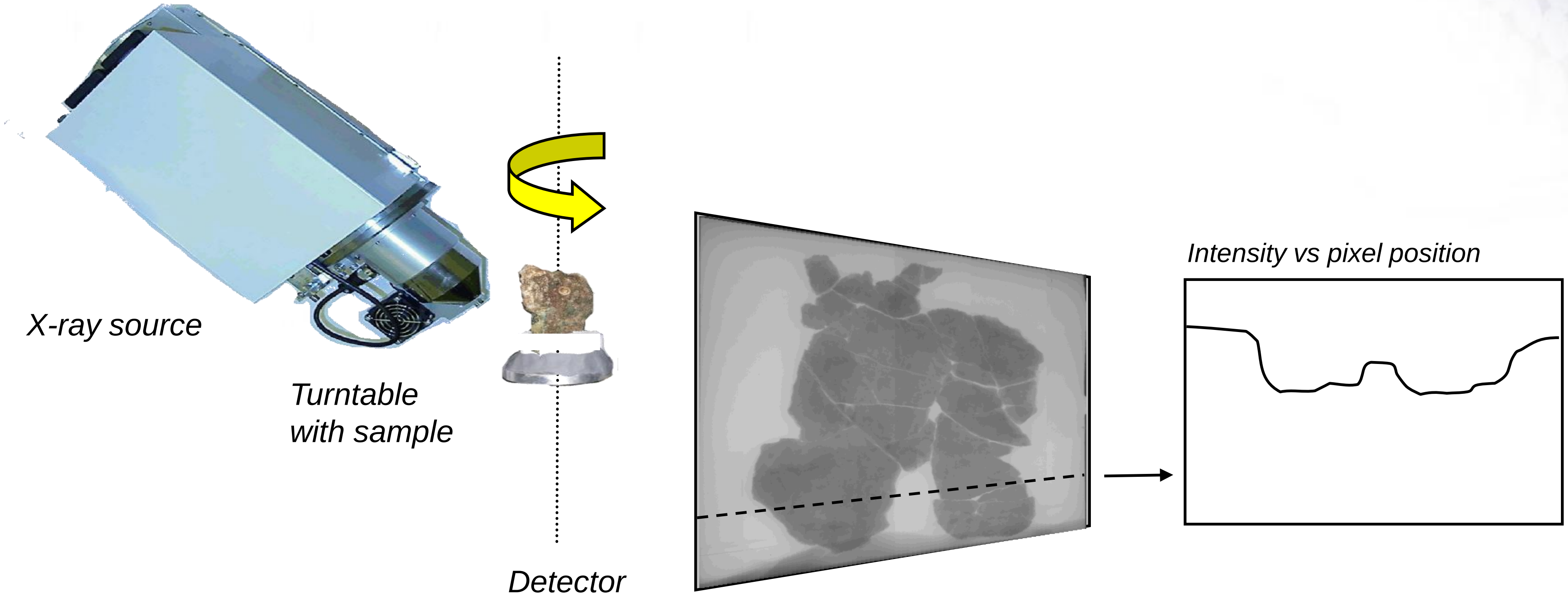
How does CT actually work?

CT requires us to penetrate the object with X-rays from all directions:



The intensity must not fall to zero at any angle

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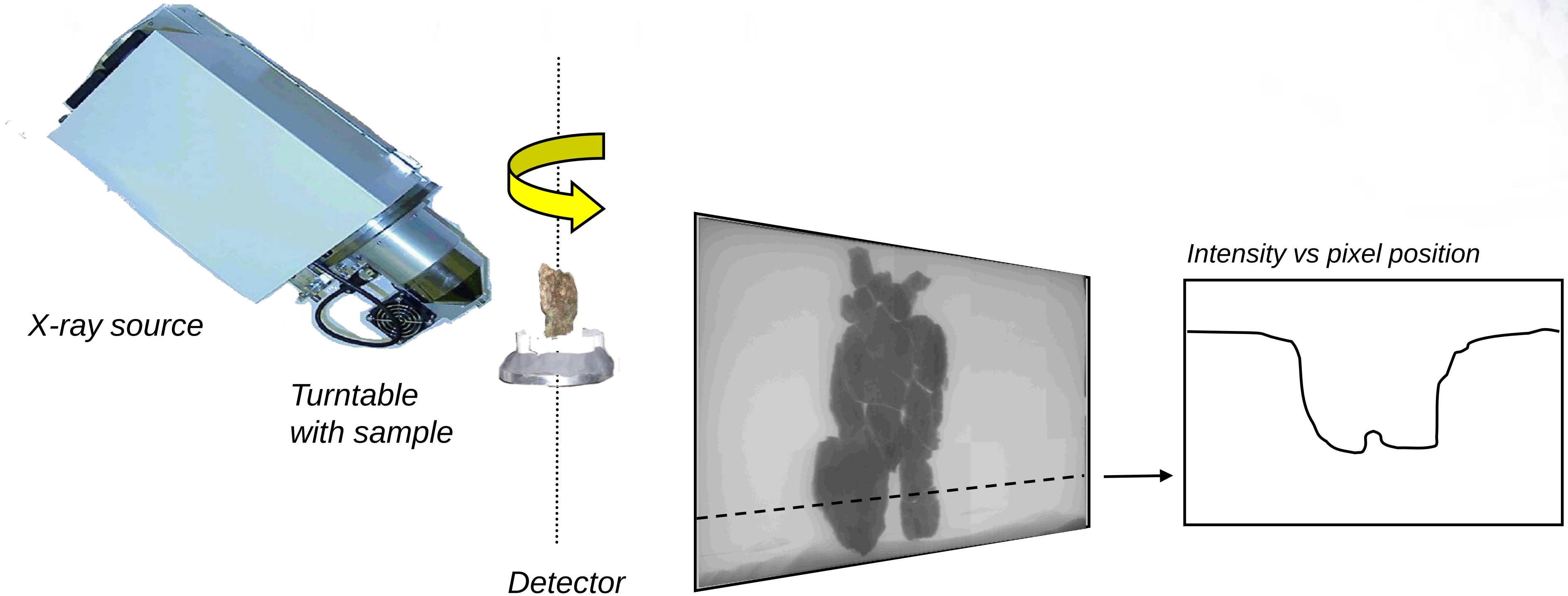

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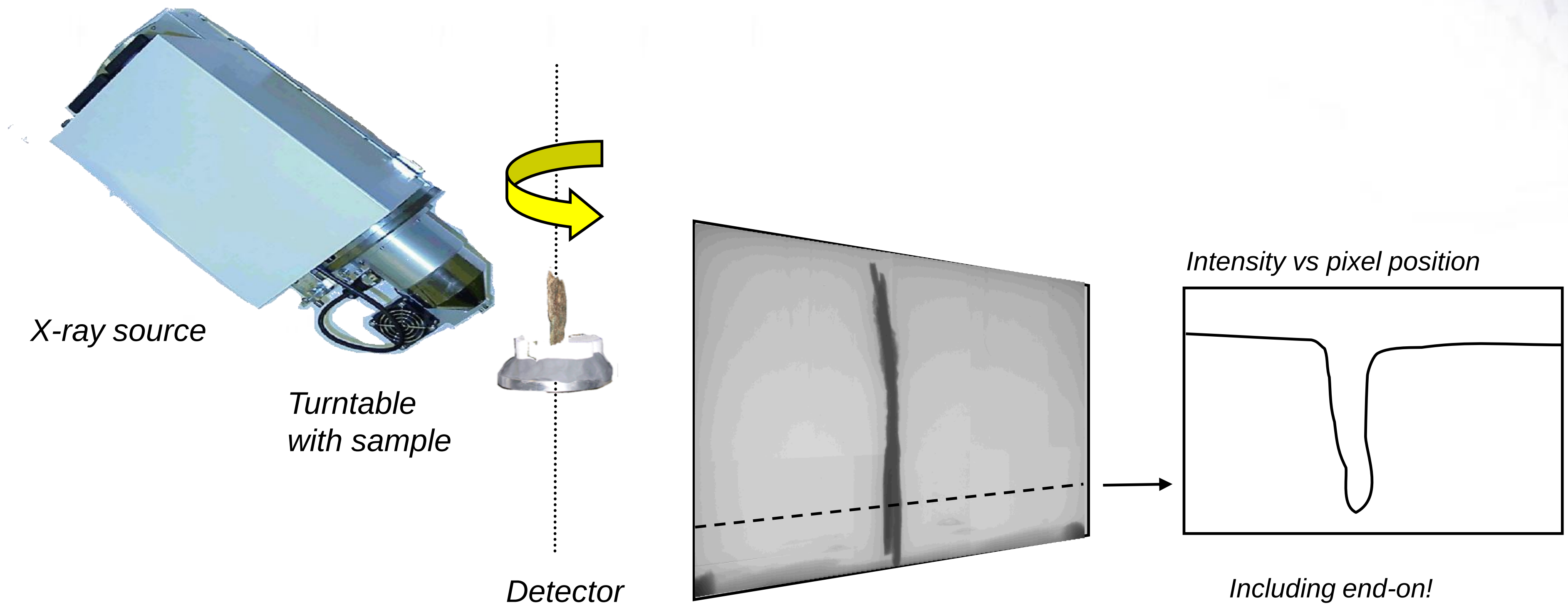

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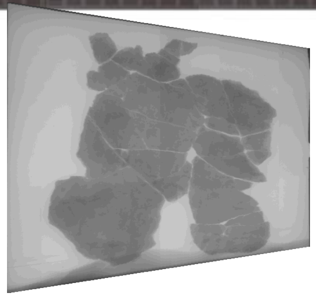
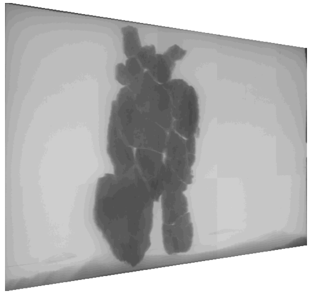
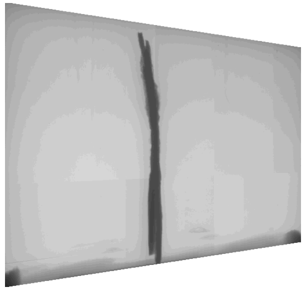
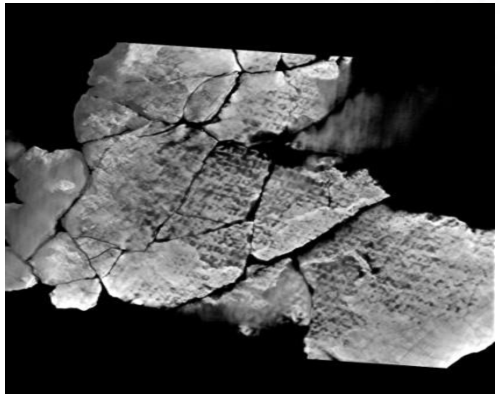




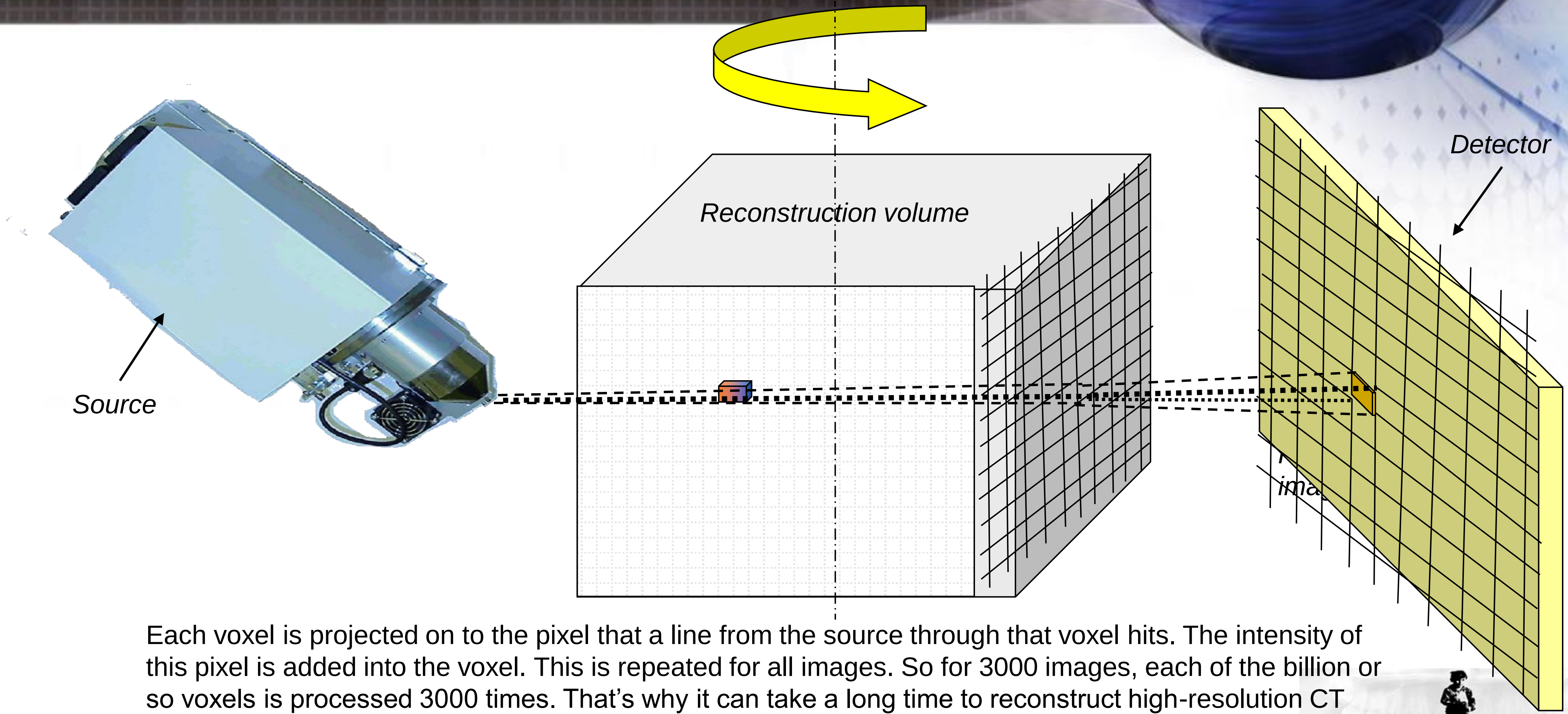




From thousands of images like these a computer algorithm generates a 3D volume which can be sliced in software to reveal the internal structure of the object.

Changing pixels into voxels

Projecting the volume elements (voxels) onto the picture elements (pixels)



Each voxel is projected on to the pixel that a line from the source through that voxel hits. The intensity of this pixel is added into the voxel. This is repeated for all images. So for 3000 images, each of the billion or so voxels is processed 3000 times. That's why it can take a long time to reconstruct high-resolution CT volumes!

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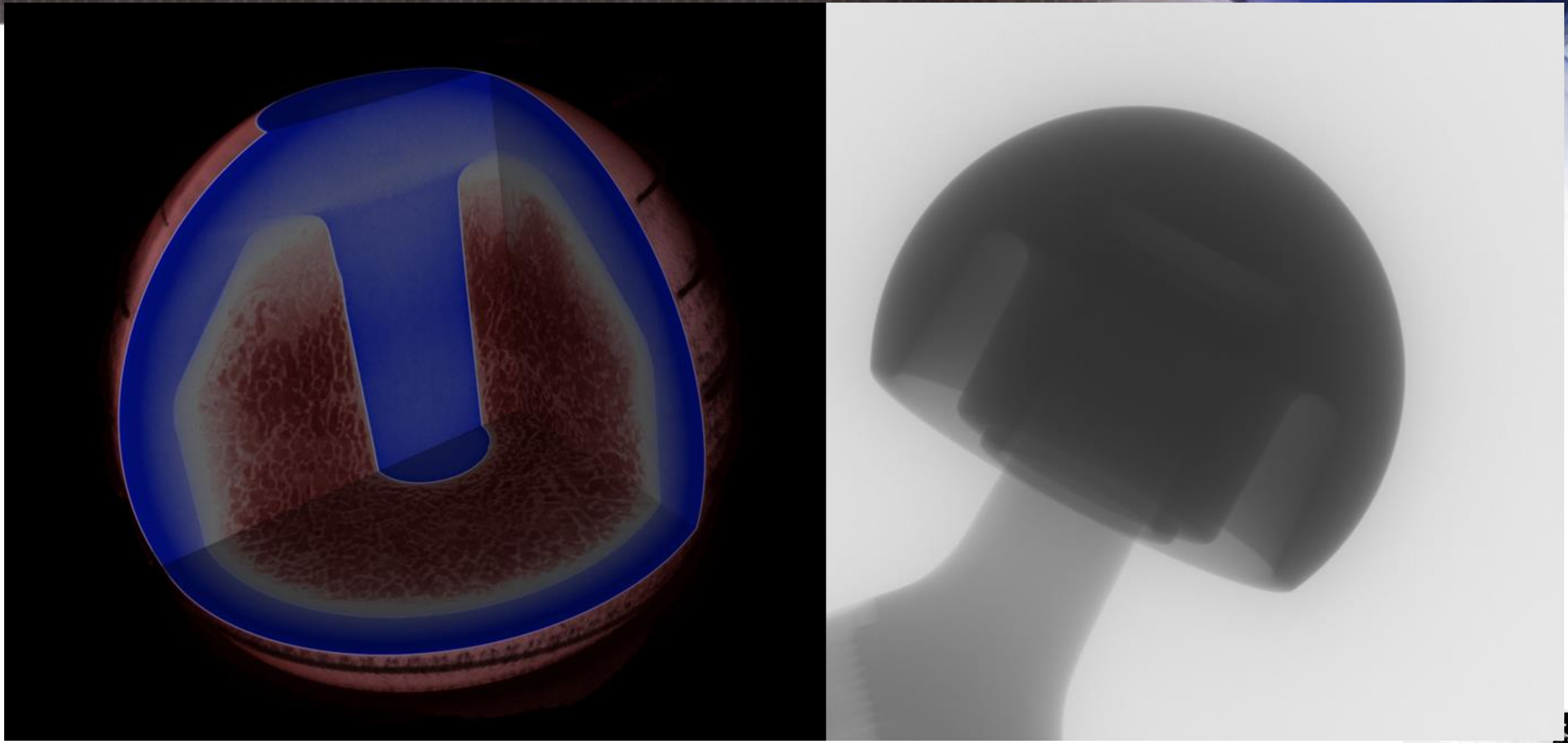
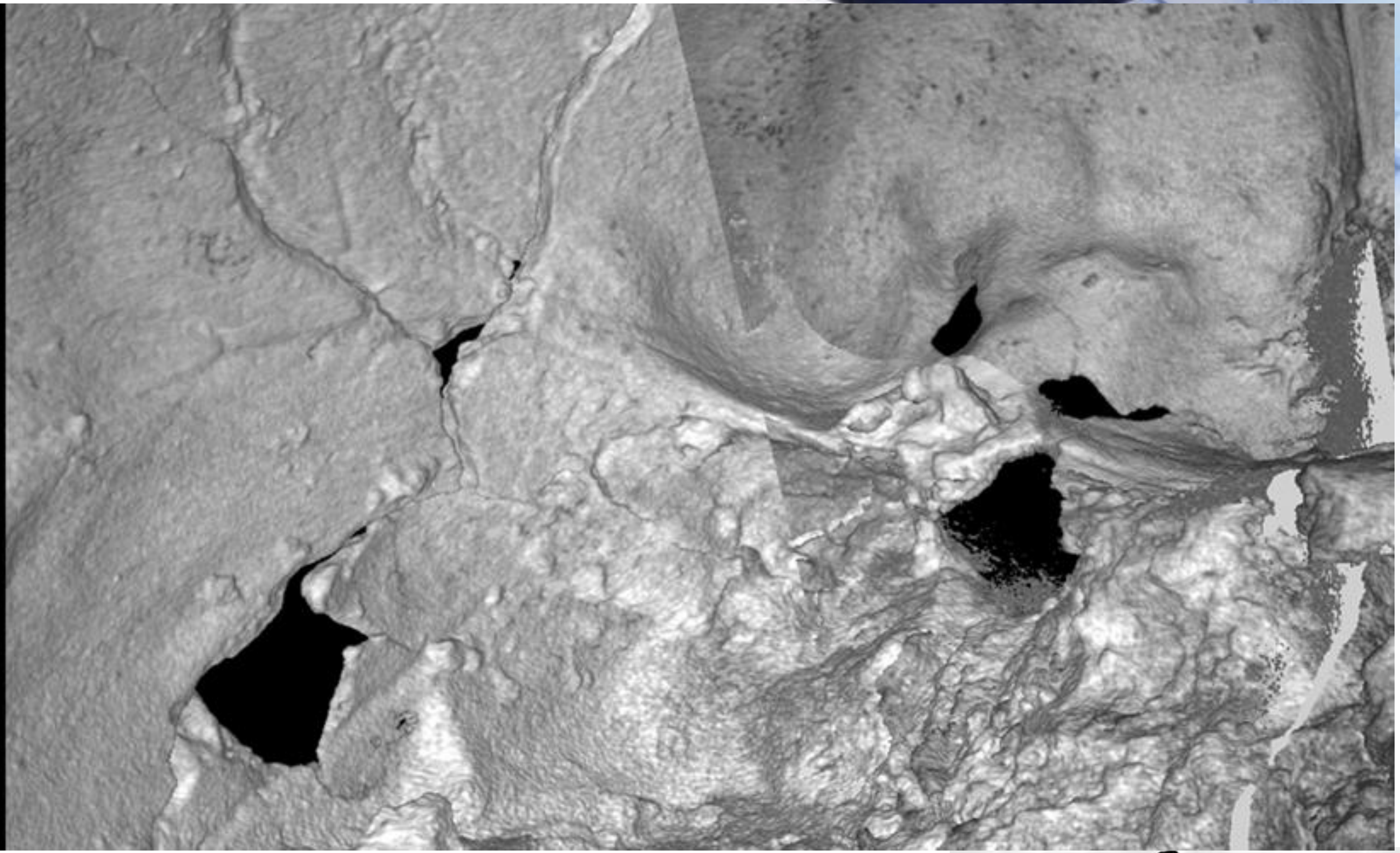
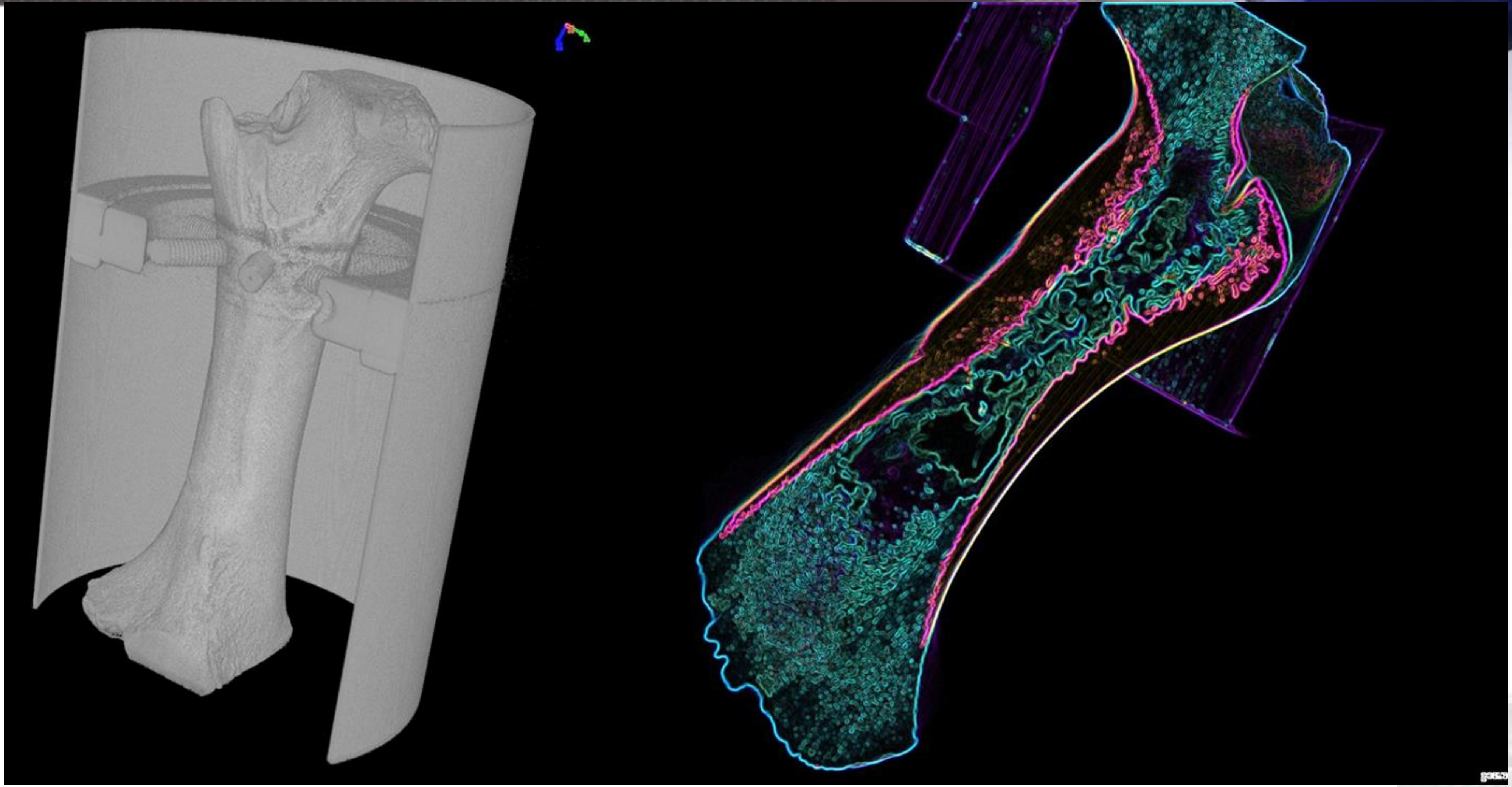
Hip replacement adhesion



Post-mortem characterisation



Bone degradation modelling



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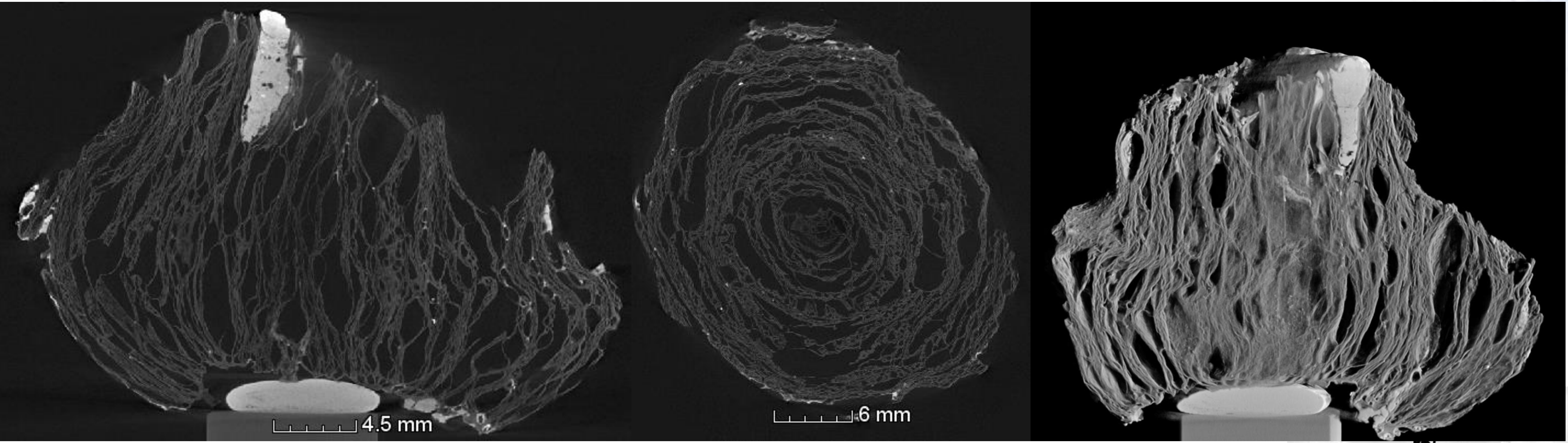
Cremation offering analysis



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Is rice nice at twice the price?

Subtitle: The evils of weevils

Fly anatomy

Fly anatomy

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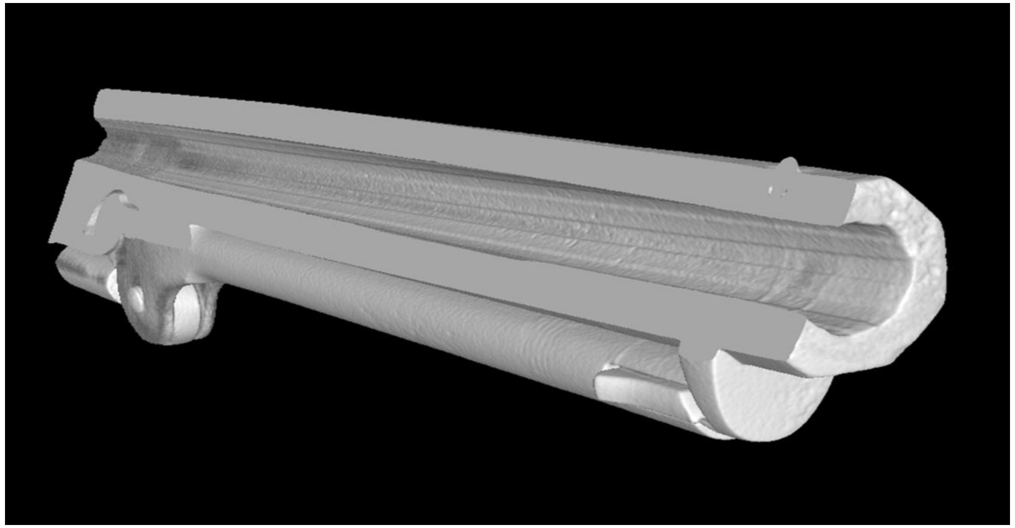
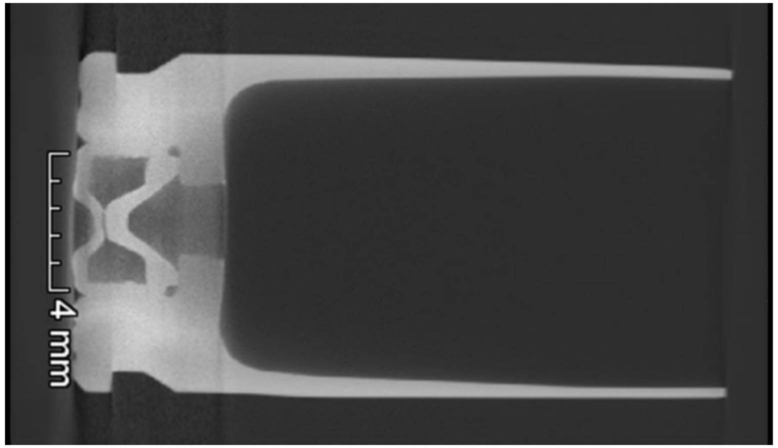
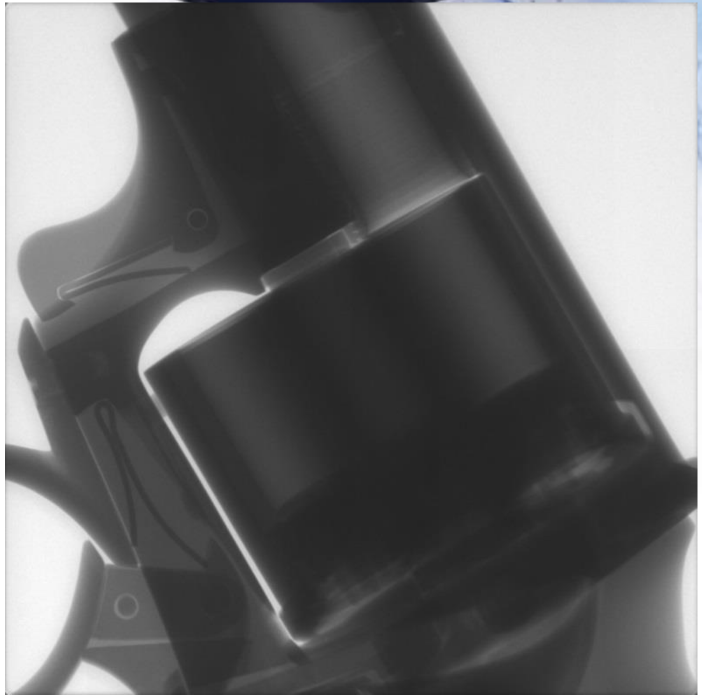
Fly anatomy

CT for ballistic analysis







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Research Council

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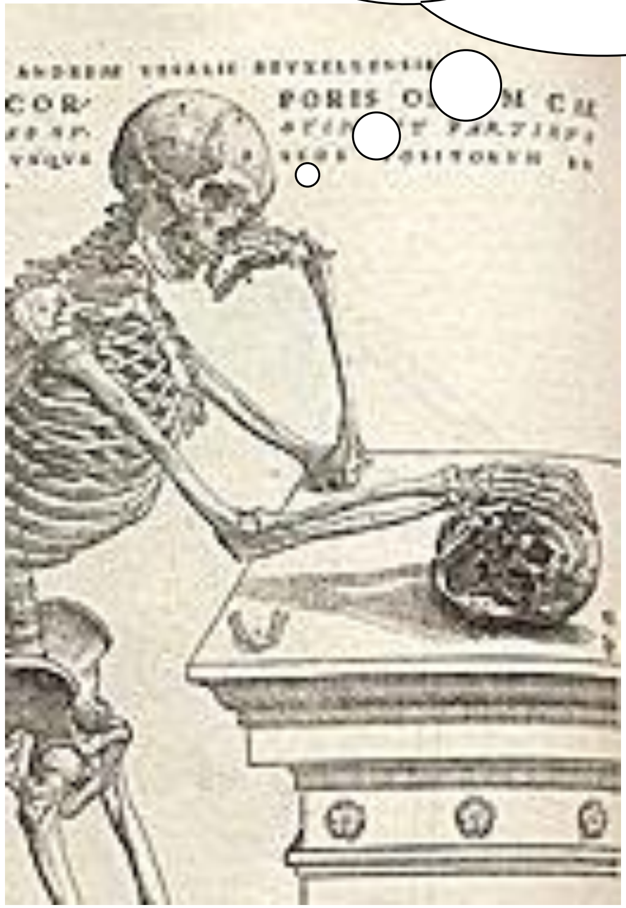
Any Questions?



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